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PATENT ABSTRACTS OF JAPAN

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(54) HIGH STRENGTH ALUMINUM ALLOY FIN MATERIAL FOR AUTOMOTIVE HEAT EXCHANGER HAVING EXCELLENT ROLLABILITY, AND ITS MANUFACTURING METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an aluminum alloy fin material for automotive heat exchanger having excellent characteristics of strength and rollability.

SOLUTION: The fin material has a composition which consists of, by weight, >2.0 to 3.0% Mn, 0.8 to 1.5% Si, 0.05 to <0.4% Fe, 0.1 to 3.0% Zn and the balance Al with inevitable impurities and in which respective contents of Mn, Si and Fe satisfy relational inequality $Mn/(Si+Fe) \geq 1.6$.

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CLAIMS

[Claim(s)]

[Claim 1]

By weight %, Mn:2.0 ** -3.0%, Si:0.8-1.5%, less than [Fe:0.05-0.4%], Zn: A high intensity aluminum alloy fin material for automobile heat exchangers excellent in rolling nature, wherein the remainder has the presentation which consists of aluminum and an inevitable impurity and content of Mn, and Si and Fe satisfies an expression of relations of Mn/(Si+Fe)>=1.6 0.1 to 3.0%.

[Claim 2]

A high intensity aluminum alloy fin material for automobile heat exchangers excellent in the rolling nature according to claim 1, wherein it contains nickel:0.01-1.0% and content of Mn, and Si and nickel is satisfied with weight % of an expression of relations of Mn-(Si+nickel) >=0.

[Claim 3]

A high intensity aluminum alloy fin material for automobile heat exchangers which was excellent in weight % at the rolling nature containing 1 of Zr:0.05-0.20% and Ti:0.01-0.30% of sorts, and two sorts according to claim 1 or 2.

[Claim 4]

A high intensity aluminum alloy fin material for automobile heat exchangers which was excellent in weight % at the rolling nature containing 1 of In:0.001-0.20% and Sn:0.01-0.50% of sorts, and two sorts according to any one of claims 1 to 3.

[Claim 5]

In a manufacturing method of a high intensity aluminum alloy fin material for automobile heat exchangers excellent in rolling nature which has the presentation

according to any one of claims 1 to 4, A manufacturing method of a high intensity aluminum alloy fin material for automobile heat exchangers excellent in rolling nature setting a cooling rate at the time of casting to s in 15-1000 ** /.

[Translation done.]

2004-176091

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]
Especially this invention relates to aluminum alloy fin materials used for the heat exchanger for cars manufactured by a brazing construction method, such as a radiator, and a manufacturing method for the same.
[0002]
[Description of the Prior Art]
The fin material which is a structural member of the heat exchanger generally used as a radiator of a car, etc. is brazed in a refrigerant passage organizer (for example, tubing material) by aluminum-Si wax material, and is metallically combined with it, and improvement in heat exchanging efficiency is aimed at by making a heat transfer area large. aluminum-Mn system alloys, such as pure aluminum system alloys, such as AA1050 alloy, and AA3003 alloy, an aluminum-Fe system alloy, etc. are used for said fin material.
As for the heat exchanger for cars, the weight saving is called for by the weight saving of the car in recent years, and the fin material is also asked for thin meat and high intensity-ization.
Although AA1050 alloy, AA3003 alloy, etc. are conventionally used as a fin material, For the purpose of high-intensity-izing, Mn:0.6-2.0%, Si:1.2-2.5%, Fe: The high-intensity aluminum-alloy fin material (refer to patent documents 1) specified with the presentation which consists of 0.05-2.0%, and Mn: The aluminum alloy fin material (refer to patent documents 2) etc. which were specified with the presentation which exceeds Si:0.4 and consists of -2% and nickel:0.1-1.0% 0.5 to 2.0% are developed.
[0003]
[Patent documents 1]
JP,H7-90446,A (the 2nd page)
[Patent documents 2]
JP,2000-273565,A (the 2nd page)
[0004]
[Problem(s) to be Solved by the Invention]
However, there was a limit in such a conventional fin material attaining high intensity. If you are going to make it attain high intensity, rolling nature is remarkably inferior, the yield will fall [the side crack at the time of rolling, etc.] remarkably greatly, or

problems, such as becoming easy to generate a fracture during rolling, will arise. Although it was what runs short of intensity and self corrosion resistance or was high intensity. erosion-proof nature and thermal conductivity run short, and there was nothing that can satisfy all of thermal conductivity, self corrosion resistance, erosion-proof nature, and intensity. When any characteristic is missing, it not only becoming impossible to satisfy the required characteristic as a fin material of a heat exchanger but the problem that heat exchanger performance degradation is not avoided has arisen.

[0005]

Then, this invention persons inquired so that they may get the fin material holding the rolling nature excellent in high intensity from the above viewpoints. It found out generating especially this problem, when crystallized material becomes big and rough. This invention provides a high intensity aluminum alloy fin material for automobile heat exchangers excellent in rolling nature, and a manufacturing method for the same based on the above-mentioned knowledge.

[0006]

[Means for Solving the Problem]

The invention according to claim 1 among high intensity aluminum alloy fin materials for automobile heat exchangers which were excellent in the rolling nature of this invention in order to solve an aforementioned problem, By weight %, Mn:2.0 ** -3.0%, Si:0.8-1.5%, less than [Fe:0.05-0.4%], Zn: 0.1 to 3.0%, the remainder has the presentation which consists of aluminum and an inevitable impurity, and content of Mn, and Si and Fe satisfies an expression of relations of Mn/(Si+Fe)>=1.6.

[0007]

A high intensity aluminum alloy fin material for automobile heat exchangers excellent in the rolling nature according to claim 2, In the invention according to claim 1, further, nickel:0.01-1.0% is contained, it has the presentation which the remainder becomes from aluminum and an inevitable impurity, and content of Mn, and Si and nickel is satisfied with weight % of an expression of relations of Mn-(Si+nickel) >=0.

[0008]

A high intensity aluminum alloy fin material for automobile heat exchangers excellent in the rolling nature according to claim 3, In the invention according to claim 1 or 2, it has the presentation which contains 1 of Zr:0.05-0.20% and Ti:0.01-0.30% of sorts, and two sorts, and the remainder becomes from aluminum and an inevitable impurity by weight % further.

[0009]

A high intensity aluminum alloy fin material for automobile heat exchangers excellent in the rolling nature according to claim 4, In the invention according to any one of claims 1 to 3, it has the presentation which contains 1 of In:0.001-0.20% and Sn:0.01-0.50% of sorts, and two sorts, and the remainder becomes from aluminum and an inevitable impurity by weight % further.
[0010]
A manufacturing method of a high intensity aluminum alloy fin material for automobile heat exchangers excellent in the rolling nature according to claim 5, In a manufacturing method of a high intensity aluminum alloy fin material for automobile heat exchangers excellent in rolling nature which has the presentation according to any one of claims 1 to 4, a cooling rate at the time of casting is set to s in 15-1000 ** /.
[0011]
A matter limited to below by this invention is explained.
Mn: 2.0 ** -3.0%
Mn crystallizes or deposits as an intermetallic compound, and raises intensity after brazing. An aluminum-Mn-Si system compound can be formed, the degree of Si dissolution of a matrix can be made low, and the melting point of a matrix can be raised. The above-mentioned effect is small in it being 2.0% or less, if it exceeds 3.0%, big and rough crystallized material will be formed and fluidity and rolling nature will fall remarkably.
[0012]
Si: 0.8 to 1.5%
Si dissolves to distribution or a matrix as aluminum-Mn-Si, aluminum-Fe-Si, aluminum-Mn-Si-Fe, and a Zr-Si system compound, and raises intensity. Mn and the degree of Zr dissolution after brazing are reduced by formation of such a compound, and thermal conductivity is raised. The above-mentioned effect is small in it being less than 0.8%, if it exceeds 1.5%, big and rough crystallized material will be formed and fluidity and rolling nature will fall remarkably. The melting point falls and it fuses at the time of brazing. Furthermore the degree of Si dissolution increases and thermal conductivity falls.
[0013]
Fe: Less than 0.05 to 0.4%
Fe crystallizes or deposits as an intermetallic compound, and raises intensity after brazing. aluminum-Mn-Fe, aluminum-Fe-Si, and an aluminum-Mn-Fe-Si system compound are formed, Mn and the degree of Si dissolution in a matrix are reduced,

and thermal conductivity is raised. Big and rough crystallized material is formed as the above-mentioned effect is small in it being less than 0.05% and it is 0.4% or more, and fluidity and rolling nature fall remarkably.

[0014]

Zn: 0.1 to 3.0%

Rather than non-connecting part material, Zn makes potential ** and acts as a sacrificial anode material. The above-mentioned effect is small in it being less than 0.1%, and a self-corrosion rate will become remarkably large if it exceeds 3.0%.

[0015]

Mn/(Si+Fe)>=1.6

Since minuteness making of the crystallized material is carried out and rolling nature is not reduced with improvement in intensity, it is preferred to satisfy the above-mentioned expression of relations. While crystallized material becomes it big and rough that an expression of relations is less than 1.6 and rolling nature falls, fault, such as causing a strong fall, arises.

[0016]

nickel: 0.01 to 1.0%

nickel crystallizes or deposits as an intermetallic compound, and raises intensity after brazing. The above-mentioned effect is small in it being less than 0.01%, and a self-corrosion rate will become remarkably large if 1.0% is exceeded. In order to form a compound of an aluminum-Mn-nickel system, superfluous simple substance Si is formed, a solidus temperature fall is caused, and it becomes easy to fuse at the time of brazing.

[0017]

Mn-(Si+nickel) >=0

In order that simple substance Si which does not form a compound may dissolve to a fin material matrix and may reduce the melting point, it is preferred to satisfy the above-mentioned expression of relations. When not filling an expression of relations, fault of becoming that it is easy to receive erosion by a melting wax at the time of brazing heat treatment, or the fin material itself fusing arises.

[0018]

Zr: 0.05-0.20%, Ti: 0.01 to 0.30%

After brazing, it distributes as a detailed intermetallic compound and Zr and Ti raise intensity. Zr: Less than [0.05%], Ti: Fluidity and rolling nature fall remarkably that the above-mentioned effect is small in it being less than 0.01%, and it is Zr:more than 0.20%, and Ti:more than 0.30%.

[0019]

In: 0.001--0.20%, Sn: 0.01 to 0.50%

Rather than non-connecting part material, In and Sn make potential ** and act as a sacrificial anode material. In: Less than [0.001%], Sn: A self-corrosion rate becomes it remarkably large that the above-mentioned effect is small in it being less than 0.01%, and it is more than In:0.20% and Sn:more than 0.50%. Rolling nature falls.

[0020]

A cooling rate at the time of casting : 15-1000 **/s

If a cooling rate at the time of casting is set to s in 15-1000 ** /, since the cooling rate is quick, formation of big and rough crystallized material can be controlled, and improvement and improving strength of further rolling nature can be performed. Since much more effect is not acquired even if it makes a cooling rate quicker 1000 ** /than s, a cooling rate is set [s] up in 15-1000 ** /.

[0021]

[Embodiment of the Invention]

The aluminum alloy used for the fin material of this invention can be manufactured with a conventional method according to the above-mentioned presentation. As for the fin material of this invention, a manufacturing method is not limited. The fin material obtained by the above usually performs corrugated processing, and uses it as a fin. The above-mentioned fin is installed and attached between tubes, brazing processing is performed, and a heat exchanger is obtained.

[0022]

[Example]

The cooling rate at the time of casting was changed, the aluminum alloy of the presentation shown in Table 1 was cast, and the rolled stock of 0.06 mm of board thickness was produced by performing hot-rolling and/or cold rolling, intermediate annealing, and cold rolling.

[0023]

Tensile strength after brazing

As evaluation of the intensity of the fin material after brazing, brazing equivalent heat treatment (a part for 600-610 **x 5 minutes, and cooling-rate/at 100 **) was performed for the fin material simple substance in high-purity-nitrogen-gas atmosphere, the tensile test was done, and tensile strength was measured. Since the tensile strength of the conventional fin material produced using AA3003 alloy was 110MPa, a thing 145 or more MPa in tensile strength was judged as there being intensity of enough.

[0024]

Rolling nature

The rolling nature of the fin material was evaluated more, without the value which **(ed) by the length of the material after rolling the total length of the side crack after rolling. The end face was cut on the same conditions after rolling to 2 mm of board thickness, and the sample of 200-mm length x100-mm width was obtained. Then, intermediate annealing for 60 s was performed at 560 ** (it was considered as the conditions for softening any material thoroughly). Then, it cold-rolled to 0.1 mm and rolling nature was evaluated. The side crack below 0.5 mm judged that it did not become a parenchyma top problem, and was aimed at a side crack of 0.5 mm or more. When it was 0.15 or less, it was judged that it was sufficient rolling nature.

[0025]

Wax-proof erosiveness

In order for the erosion depended for cursing at the time of brazing heat treatment and a fin material's own melting to estimate buckling of a fin material, etc., the fin material melting starting temperature at the time of carrying out temperature up at the rate of brazing heat treatment equivalent 10 ** /, and min was investigated. Since brazing heat treatment temperature was carried out at about 600 **, fin material melting starting temperature judged what is not less than 610 ** that wax-proof erosiveness is enough.

[0026]

Although the result of each evaluation was shown in Table 1, each this invention material showed the outstanding intensity and rolling nature.

[0027]

[Table 1]

	合金組成(重量%)									Mn/(Si+Fe)	Mn−(Si+Ni)	鋳造冷却速度(℃/s)	ろう付後引張強さ(MPa)	圧延性	フィン溶融開始温度(℃)
	Si	Fe	Mn	Zn	Ni	Zr	Ti	In	Sn						
実施例1	1.0	0.2	2.4	1.5	−	−	−	−	−	2.00	−	200	160	0.07	623
実施例2	1.0	0.2	2.4	1.5	0.5	−	−	−	−	2.00	0.9	200	172	0.12	617
実施例3	1.0	0.2	2.4	1.5	−	0.1	0.1	−	−	2.00	−	200	165	0.10	623
実施例4	1.0	0.2	2.4	1.5	−	−	−	0.05	0.1	2.00	−	200	160	0.11	622
実施例5	1.0	0.2	2.4	1.5	0.5	0.1	0.1	−	−	2.00	0.9	200	176	0.12	616
実施例6	1.0	0.2	2.4	1.5	0.5	−	−	0.05	0.1	2.00	0.9	200	172	0.11	615
実施例7	1.0	0.2	2.4	1.5	−	0.1	0.1	0.05	0.1	2.00	−	200	165	0.09	623
実施例8	1.0	0.2	2.4	1.5	0.5	0.1	0.1	0.05	0.1	2.00	0.9	200	177	0.10	616
実施例9	1.0	0.2	2.4	1.5	0.5	−	−	−	−	2.00	0.9	10	155	0.14	616
実施例10	1.0	0.05	2.4	1.5	−	−	−	−	−	2.29	−	200	165	0.12	616
比較例1	1.5	0.3	2.4	1.5	1.0	−	−	−	−	1.33	−0.1	200	140	0.18	595
比較例2	1.0	0.2	1.5	1.5	0.5	−	−	−	−	1.25	0.9	200	158	0.16	617
比較例3	1.0	0.8	2.4	1.5	−	−	−	−	−	1.33	−	200	145	0.19	620

[0028]

[Effect of the Invention]

As explained above, according to a high intensity aluminum alloy fin material for automobile heat exchangers excellent in the rolling nature of this invention, and a manufacturing method for the same, the outstanding intensity and the fin material which has rolling nature are obtained.

[Translation done.]

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TECHNICAL FIELD

[Field of the Invention]

Especially this invention relates to aluminum alloy fin materials used for the heat exchanger for cars manufactured by a brazing construction method, such as a radiator, and a manufacturing method for the same.

[0002]

[Translation done.]

PRIOR ART

[Description of the Prior Art]

The fin material which is a structural member of the heat exchanger generally used as a radiator of a car, etc. is brazed in a refrigerant passage organizer (for example, tubing material) by aluminum-Si wax material, and is metallically combined with it, and improvement in heat exchanging efficiency is aimed at by making a heat transfer area large. aluminum-Mn system alloys, such as pure aluminum system alloys, such as AA1050 alloy, and AA3003 alloy, an aluminum-Fe system alloy, etc. are used for said fin material.

As for the heat exchanger for cars, the weight saving is called for by the weight saving of the car in recent years, and the fin material is also asked for thin meat and high intensity-ization.

Although AA1050 alloy, AA3003 alloy, etc. are conventionally used as a fin material, For the purpose of high-intensity-izing, Mn:0.6-2.0%, Si:1.2-2.5%, Fe: The high-intensity aluminum-alloy fin material (refer to patent documents 1) specified with the presentation which consists of 0.05-2.0%, and Mn: The aluminum alloy fin material (refer to patent documents 2) etc. which were specified with the presentation which exceeds Si:0.4 and consists of -2% and nickel:0.1-1.0% 0.5 to 2.0% are developed.

[0003]

[Patent documents 1]

JP,H7-90446,A (the 2nd page)

[Patent documents 2]

JP,2000-273565,A (the 2nd page)

[0004]

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention]

As explained above, according to a high intensity aluminum alloy fin material for automobile heat exchangers excellent in the rolling nature of this invention, and a manufacturing method for the same, the outstanding intensity and the fin material which has rolling nature are obtained.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]

However, there was a limit in such a conventional fin material attaining high intensity. If you are going to make it attain high intensity, rolling nature is remarkably inferior, the yield will fall [the side crack at the time of rolling, etc.] remarkably greatly, or problems, such as becoming easy to generate a fracture during rolling, will arise. Although it was what runs short of intensity and self corrosion resistance or was high intensity. erosion-proof nature and thermal conductivity run short, and there was nothing that can satisfy all of thermal conductivity, self corrosion resistance, erosion-proof nature, and intensity. When any characteristic is missing, it not only becoming impossible to satisfy the required characteristic as a fin material of a heat exchanger but the problem that heat exchanger performance degradation is not avoided has arisen.

[0005]

Then, this invention persons inquired so that they may get the fin material holding the rolling nature excellent in high intensity from the above viewpoints. It found out generating especially this problem, when crystallized material becomes big and rough. This invention provides a high intensity aluminum alloy fin material for automobile heat exchangers excellent in rolling nature, and a manufacturing method for the same based on the above-mentioned knowledge.

[0006]

[Translation done.]

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MEANS

[Means for Solving the Problem]
The invention according to claim 1 among high intensity aluminum alloy fin materials for automobile heat exchangers which were excellent in the rolling nature of this invention in order to solve an aforementioned problem, By weight %, Mn:2.0 ** -3.0%, Si:0.8-1.5%, less than [Fe:0.05-0.4%], Zn: 0.1 to 3.0%, the remainder has the presentation which consists of aluminum and an inevitable impurity, and content of Mn, and Si and Fe satisfies an expression of relations of Mn/(Si+Fe)>=1.6.
[0007]
A high intensity aluminum alloy fin material for automobile heat exchangers excellent in the rolling nature according to claim 2, In the invention according to claim 1, further, nickel:0.01-1.0% is contained, it has the presentation which the remainder becomes from aluminum and an inevitable impurity, and content of Mn, and Si and nickel is satisfied with weight % of an expression of relations of Mn-(Si+nickel) >=0.
[0008]
A high intensity aluminum alloy fin material for automobile heat exchangers excellent in the rolling nature according to claim 3, In the invention according to claim 1 or 2, it has the presentation which contains 1 of Zr:0.05-0.20% and Ti:0.01-0.30% of sorts, and two sorts, and the remainder becomes from aluminum and an inevitable impurity by weight % further.
[0009]
A high intensity aluminum alloy fin material for automobile heat exchangers excellent in the rolling nature according to claim 4, In the invention according to any one of claims 1 to 3, it has the presentation which contains 1 of In:0.001-0.20% and Sn:0.01-0.50% of sorts, and two sorts, and the remainder becomes from aluminum and an inevitable impurity by weight % further.
[0010]
A manufacturing method of a high intensity aluminum alloy fin material for automobile heat exchangers excellent in the rolling nature according to claim 5, In a manufacturing method of a high intensity aluminum alloy fin material for automobile heat exchangers excellent in rolling nature which has the presentation according to any one of claims 1 to 4, a cooling rate at the time of casting is set to s in 15-1000 ** /.
[0011]
A matter limited to below by this invention is explained.

Mn: 2.0 ** -3.0%
Mn crystallizes or deposits as an intermetallic compound, and raises intensity after brazing. An aluminum-Mn-Si system compound can be formed, the degree of Si dissolution of a matrix can be made low, and the melting point of a matrix can be raised. The above-mentioned effect is small in it being 2.0% or less, if it exceeds 3.0%, big and rough crystallized material will be formed and fluidity and rolling nature will fall remarkably.
[0012]
Si: 0.8 to 1.5%
Si dissolves to distribution or a matrix as aluminum-Mn-Si, aluminum-Fe-Si, aluminum-Mn-Si-Fe, and a Zr-Si system compound, and raises intensity. Mn and the degree of Zr dissolution after brazing are reduced by formation of such a compound, and thermal conductivity is raised. The above-mentioned effect is small in it being less than 0.8%, if it exceeds 1.5%, big and rough crystallized material will be formed and fluidity and rolling nature will fall remarkably. The melting point falls and it fuses at the time of brazing. Furthermore the degree of Si dissolution increases and thermal conductivity falls.
[0013]
Fe: Less than 0.05 to 0.4%
Fe crystallizes or deposits as an intermetallic compound, and raises intensity after brazing. aluminum-Mn-Fe, aluminum-Fe-Si, and an aluminum-Mn-Fe-Si system compound are formed, Mn and the degree of Si dissolution in a matrix are reduced, and thermal conductivity is raised. Big and rough crystallized material is formed as the above-mentioned effect is small in it being less than 0.05% and it is 0.4% or more, and fluidity and rolling nature fall remarkably.
[0014]
Zn: 0.1 to 3.0%
Rather than non-connecting part material, Zn makes potential ** and acts as a sacrificial anode material. The above-mentioned effect is small in it being less than 0.1%, and a self-corrosion rate will become remarkably large if it exceeds 3.0%.
[0015]
Mn/(Si+Fe)>=1.6
Since minuteness making of the crystallized material is carried out and rolling nature is not reduced with improvement in intensity, it is preferred to satisfy the above-mentioned expression of relations. While crystallized material becomes it big and rough that an expression of relations is less than 1.6 and rolling nature falls, fault,

such as causing a strong fall, arises.
[0016]
nickel: 0.01 to 1.0%
nickel crystallizes or deposits as an intermetallic compound, and raises intensity after brazing. The above-mentioned effect is small in it being less than 0.01%, and a self-corrosion rate will become remarkably large if 1.0% is exceeded. In order to form a compound of an aluminum-Mn-nickel system, superfluous simple substance Si is formed, a solidus temperature fall is caused, and it becomes easy to fuse at the time of brazing.
[0017]
Mn-(Si+nickel) >=0
In order that simple substance Si which does not form a compound may dissolve to a fin material matrix and may reduce the melting point, it is preferred to satisfy the above-mentioned expression of relations. When not filling an expression of relations, fault of becoming that it is easy to receive erosion by a melting wax at the time of brazing heat treatment, or the fin material itself fusing arises.
[0018]
Zr: 0.05-0.20%, Ti: 0.01 to 0.30%
After brazing, it distributes as a detailed intermetallic compound and Zr and Ti raise intensity. Zr: Less than [0.05%], Ti: Fluidity and rolling nature fall remarkably that the above-mentioned effect is small in it being less than 0.01%, and it is Zr:more than 0.20%, and Ti:more than 0.30%.
[0019]
In: 0.001--0.20%, Sn: 0.01 to 0.50%
Rather than non-connecting part material, In and Sn make potential ** and act as a sacrificial anode material. In: Less than [0.001%], Sn: A self-corrosion rate becomes it remarkably large that the above-mentioned effect is small in it being less than 0.01%, and it is more than In:0.20% and Sn:more than 0.50%. Rolling nature falls.
[0020]
A cooling rate at the time of casting : 15-1000 **/s
If a cooling rate at the time of casting is set to s in 15-1000 ** /, since the cooling rate is quick, formation of big and rough crystallized material can be controlled, and improvement and improving strength of further rolling nature can be performed. Since much more effect is not acquired even if it makes a cooling rate quicker 1000 ** /than s, a cooling rate is set [s] up in 15-1000 ** /.
[0021]

[Embodiment of the Invention]
The aluminum alloy used for the fin material of this invention can be manufactured with a conventional method according to the above-mentioned presentation. As for the fin material of this invention, a manufacturing method is not limited. The fin material obtained by the above usually performs corrugated processing, and uses it as a fin. The above-mentioned fin is installed and attached between tubes, brazing processing is performed, and a heat exchanger is obtained.
[0022]

[Translation done.]

EXAMPLE

[Example]

The cooling rate at the time of casting was changed, the aluminum alloy of the presentation shown in Table 1 was cast, and the rolled stock of 0.06 mm of board thickness was produced by performing hot-rolling and/or cold rolling, intermediate annealing, and cold rolling.

[0023]

Tensile strength after brazing

As evaluation of the intensity of the fin material after brazing, brazing equivalent heat treatment (a part for 600-610 **x 5 minutes, and cooling-rate/at 100 **) was performed for the fin material simple substance in high-purity-nitrogen-gas atmosphere, the tensile test was done, and tensile strength was measured. Since the tensile strength of the conventional fin material produced using AA3003 alloy was 110MPa, a thing 145 or more MPa in tensile strength was judged as there being intensity of enough.

[0024]

Rolling nature

The rolling nature of the fin material was evaluated more, without the value which **(ed) by the length of the material after rolling the total length of the side crack after rolling. The end face was cut on the same conditions after rolling to 2 mm of board thickness, and the sample of 200-mm length x100-mm width was obtained. Then, intermediate annealing for 60 s was performed at 560 ** (it was considered as the conditions for softening any material thoroughly). Then, it cold-rolled to 0.1 mm and rolling nature was evaluated. The side crack below 0.5 mm judged that it did not become a parenchyma top problem, and was aimed at a side crack of 0.5 mm or more. When it was 0.15 or less, it was judged that it was sufficient rolling nature.

[0025]

Wax-proof erosiveness

In order for the erosion depended for cursing at the time of brazing heat treatment and a fin material's own melting to estimate buckling of a fin material, etc., the fin material melting starting temperature at the time of carrying out temperature up at the rate of brazing heat treatment equivalent 10 ** /, and min was investigated. Since brazing heat treatment temperature was carried out at about 600 **, fin material melting starting temperature judged what is not less than 610 ** that wax-proof erosiveness is enough.

[0026]

Although the result of each evaluation was shown in Table 1, each this invention material showed the outstanding intensity and rolling nature.

[0027]

[Table 1]

	合金組成(重量%)									Mn/(Si+Fe)	Mn−(Si+Ni)	鋳造冷却速度(℃/s)	ろう付後引張強さ(MPa)	圧延性	フィン溶融開始温度(℃)
	Si	Fe	Mn	Zn	Ni	Zr	Ti	In	Sn						
実施例1	1.0	0.2	2.4	1.5	−	−	−	−	−	2.00	−	200	160	0.07	623
実施例2	1.0	0.2	2.4	1.5	0.5	−	−	−	−	2.00	0.9	200	172	0.12	617
実施例3	1.0	0.2	2.4	1.5	−	0.1	0.1	−	−	2.00	−	200	165	0.10	623
実施例4	1.0	0.2	2.4	1.5	−	−	−	0.05	0.1	2.00	−	200	160	0.11	622
実施例5	1.0	0.2	2.4	1.5	0.5	0.1	0.1	−	−	2.00	0.9	200	176	0.12	616
実施例6	1.0	0.2	2.4	1.5	0.5	−	−	0.05	0.1	2.00	0.9	200	172	0.11	615
実施例7	1.0	0.2	2.4	1.5	−	0.1	0.1	0.05	0.1	2.00	−	200	165	0.09	623
実施例8	1.0	0.2	2.4	1.5	0.5	0.1	0.1	0.05	0.1	2.00	0.9	200	177	0.10	616
実施例9	1.0	0.2	2.4	1.5	0.5	−	−	−	−	2.00	0.9	10	155	0.14	616
実施例10	1.0	0.05	2.4	1.5	−	−	−	−	−	2.29	−	200	165	0.12	616
比較例1	1.5	0.3	2.4	1.5	1.0	−	−	−	−	1.33	-0.1	200	140	0.18	595
比較例2	1.0	0.2	1.5	1.5	0.5	−	−	−	−	1.25	0.9	200	158	0.16	617
比較例3	1.0	0.8	2.4	1.5	−	−	−	−	−	1.33	−	200	145	0.19	620

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(54)【発明の名称】圧延性に優れた自動車熱交換器用高強度アルミニウム合金フィン材及びその製造方法

(57)【要約】
【課題】自動車熱交換器用アルミニウム合金フィン材について、強度、圧延性に優れた特性を得る。
【解決手段】フィン材の組成を、重量％で、Mn：2．0超～3．0％、Si：0．8～1．5％、Fe　0．05～0．4％未満、Zn：0．1～3．0％、残部がAl及び不可避不純物からなる組成を有し、MnとSiとFeの含有量が、Mn／（Si＋Fe）≧1．6の関係式を満足するものとする。
【効果】強度、圧延性に優れた熱交換器用アルミニウム合金フィン材が得られる。
【選択図】　なし

【特許請求の範囲】
【請求項１】
重量％で、Ｍｎ：２．０超～３．０％、Ｓｉ：０．８～１．５％、Ｆｅ：０．０５～０．４％未満、Ｚｎ：０．１～３．０％、残部がＡｌ及び不可避不純物からなる組成を有し、ＭｎとＳｉとＦｅの含有量が、Ｍｎ／（Ｓｉ＋Ｆｅ）≧１．６の関係式を満足することを特徴とする圧延性に優れた自動車熱交換器用高強度アルミニウム合金フィン材。
【請求項２】
さらに、重量％で、Ｎｉ：０．０１～１．０％を含有し、ＭｎとＳｉとＮｉの含有量が、Ｍｎ－（Ｓｉ＋Ｎｉ）≧０の関係式を満足することを特徴とする請求項１記載の圧延性に優れた自動車熱交換器用高強度アルミニウム合金フィン材。
【請求項３】
さらに、重量％で、Ｚｒ：０．０５～０．２０％、Ｔｉ：０．０１～０．３０％のうちの１種または２種を含有することを特徴とする請求項１又は２記載の圧延性に優れた自動車熱交換器用高強度アルミニウム合金フィン材。
【請求項４】
さらに、重量％で、Ｉｎ：０．００１～０．２０％、Ｓｎ：０．０１～０．５０％のうちの１種または２種を含有することを特徴とする請求項１～３のいずれかに記載の圧延性に優れた自動車熱交換器用高強度アルミニウム合金フィン材。
【請求項５】
請求項１～４のいずれかに記載の組成を有する圧延性に優れた自動車熱交換器用高強度アルミニウム合金フィン材の製造方法において、鋳造時の冷却速度を、１５～１０００℃／ｓとすることを特徴とする圧延性に優れた自動車熱交換器用高強度アルミニウム合金フィン材の製造方法。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】
本発明は、ラジエータなど、特にろう付工法により製造される自動車用熱交換器に使用されるアルミニウム合金フィン材及びその製造方法に関するものである。
【０００２】
【従来の技術】
一般に自動車のラジエータなどとして用いられている熱交換器の構造部材であるフィン材は冷媒通路形成体（例えば管材）にＡｌ－Ｓｉろう材によりろう付して金属的に結合させ、伝熱面積を広くすることにより熱交換効率の向上を図っている。前記フィン材にはＡＡ１０５０合金などの純Ａｌ系合金、ＡＡ３００３合金などのＡｌ－Ｍｎ系合金、Ａｌ－Ｆｅ系合金などが用いられている。
近年の自動車の軽量化により自動車用熱交換器もまた軽量化が求められており、フィン材にも薄肉、高強度化が求められている。
従来はフィン材としてＡＡ１０５０合金、ＡＡ３００３合金などが用いられているが、高強度化を目的として、Ｍｎ：０．６～２．０％、Ｓｉ：１．２～２．５％、Ｆｅ：０．０５～２．０％からなる組成で規定した高強度Ａｌ合金フィン材（特許文献１参照）や、Ｍｎ：０．５～２．０％、Ｓｉ：０．４越え～２％、Ｎｉ：０．１～１．０％からなる組成で規定したＡｌ合金フィン材（特許文献２参照）などが開発されている。
【０００３】
【特許文献１】
特開平７－９０４４６号公報（第２頁）
【特許文献２】
特開２０００－２７３５６５号公報（第２頁）
【０００４】
【発明が解決しようとする課題】
しかし、このような従来のフィン材でも高強度を達成するには限界があった。また、高強

度を達成させようとすると、圧延性が著しく劣り、圧延時のサイドクラックなどが著しく大きく歩留りが低下したり、圧延中に破断が発生しやすくなるなどの問題が生じる。強度や自己耐食性が不足するものであったり、高強度ではあるが、耐エロージョン性や熱伝導性が不足するものであり、熱伝導性、自己耐食性や耐エロージョン性と強度を全て満足できるものはなかった。いずれの特性も欠けてしまうことによって、熱交換器のフィン材としての必要な特性を満足できなくなるばかりでなく、熱交換器性能の低下が避けられないという問題が生じてきた。

【０００５】

そこで、本発明者らは上述のような観点から、高強度で優れた圧延性を保持するフィン材を得るべく研究を行った。この問題は特に、晶出物が粗大化することにより発生することを見出した。

本発明は、上記の知見に基づき、圧延性に優れた自動車熱交換器用高強度アルミニウム合金フィン材及びその製造方法を提供するものである。

【０００６】

【課題を解決するための手段】

上記課題を解決するため本発明の圧延性に優れた自動車熱交換器用高強度アルミニウム合金フィン材のうち、請求項１記載の発明は、重量％で、Ｍｎ：２．０超～３．０％、Ｓｉ：０．８～１．５％、Ｆｅ：０．０５～０．４％未満、Ｚｎ：０．１～３．０％、残部がＡｌ及び不可避不純物からなる組成を有し、ＭｎとＳｉとＦｅの含有量が、Ｍｎ／（Ｓｉ＋Ｆｅ）≧１．６の関係式を満足することを特徴とする。

【０００７】

請求項２記載の圧延性に優れた自動車熱交換器用高強度アルミニウム合金フィン材は、請求項１記載の発明において、さらに、重量％で、Ｎｉ：０．０１～１．０％を含有し、残部がＡｌと不可避不純物からなる組成を有し、ＭｎとＳｉとＮｉの含有量が、Ｍｎ－（Ｓｉ＋Ｎｉ）≧０の関係式を満足することを特徴とする。

【０００８】

請求項３記載の圧延性に優れた自動車熱交換器用高強度アルミニウム合金フィン材は、請求項１又は２記載の発明において、さらに、重量％で、Ｚｒ：０．０５～０．２０％、Ｔｉ：０．０１～０．３０％のうちの１種または２種を含有し、残部がＡｌ及び不可避不純物からなる組成を有することを特徴とする。

【０００９】

請求項４記載の圧延性に優れた自動車熱交換器用高強度アルミニウム合金フィン材は、請求項１～３のいずれかに記載の発明において、さらに、重量％で、Ｉｎ：０．００１～０．２０％、Ｓｎ：０．０１～０．５０％のうちの１種または２種を含有し、残部がＡｌ及び不可避不純物からなる組成を有することを特徴とする。

【００１０】

請求項５記載の圧延性に優れた自動車熱交換器用高強度アルミニウム合金フィン材の製造方法は、請求項１～４のいずれかに記載の組成を有する圧延性に優れた自動車熱交換器用高強度アルミニウム合金フィン材の製造方法において、鋳造時の冷却速度を、１５～１０００℃／ｓとすることを特徴とする。

【００１１】

以下に、本発明で限定する事項について説明する。

Ｍｎ：２．０超～３．０％

Ｍｎは、金属間化合物として晶出または析出し、ろう付後の強度を向上させる。また、Ａｌ－Ｍｎ－Ｓｉ系化合物を形成して、マトリックスのＳｉ固溶度を低くし、マトリックスの融点を向上させることができる。２．０％以下であると上記効果が小さく、３．０％を超えると、粗大晶出物を形成し鋳造性や圧延性が著しく低下する。

【００１２】

Ｓｉ：０．８～１．５％

Ｓｉは、Ａｌ－Ｍｎ－Ｓｉ、Ａｌ－Ｆｅ－Ｓｉ、Ａｌ－Ｍｎ－Ｓｉ－Ｆｅ、Ｚｒ－Ｓｉ系

化合物として分散あるいはマトリックスに固溶して強度を向上させる。また、このような化合物の形成によりろう付後のＭｎやＺｒ固溶度を低下させ熱伝導性を向上させる。０．８％未満であると上記効果が小さく、１．５％を超えると、粗大晶出物を形成し鋳造性や圧延性が著しく低下する。また、融点が低下し、ろう付時に溶融する。さらにＳｉ固溶度が増大し、熱伝導性が低下する。

【００１３】

Ｆｅ：０．０５～０．４％未満

Ｆｅは、金属間化合物として晶出または析出し、ろう付後の強度を向上させる。また、Ａｌ－Ｍｎ－Ｆｅ、Ａｌ－Ｆｅ－Ｓｉ、Ａｌ－Ｍｎ－Ｆｅ－Ｓｉ系化合物を形成して、マトリックス中のＭｎやＳｉ固溶度を低下させ、熱伝導性を向上させる。０．０５％未満であると上記効果が小さく、０．４％以上であると、粗大晶出物を形成し鋳造性や圧延性が著しく低下する。

【００１４】

Ｚｎ：０．１～３．０％

Ｚｎは、非接合部材よりも電位を卑にし、犠牲陽極材として作用する。０．１％未満であると上記効果が小さく、３．０％を超えると自己腐食速度が著しく大きくなる。

【００１５】

Ｍｎ／（Ｓｉ＋Ｆｅ）≧１．６

晶出物を微細化させて、強度の向上とともに圧延性を低下させないことから、上記関係式を満足することが好ましい。関係式が１．６未満であると晶出物が粗大化し圧延性が低下するとともに強度の低下を招くなどの不具合が生じる。

【００１６】

Ｎｉ：０．０１～１．０％

Ｎｉは、金属間化合物として晶出または析出し、ろう付後の強度を向上させる。０．０１％未満であると上記効果が小さく、１．０％を越えると自己腐食速度が著しく大きくなる。また、Ａｌ－Ｍｎ－Ｎｉ系の化合物を形成するため、過剰な単体Ｓｉを形成し、固相線温度低下を招き、ろう付時に溶融しやすくなる。

【００１７】

Ｍｎ－（Ｓｉ＋Ｎｉ）≧０

化合物を形成しない単体Ｓｉがフィン材マトリックスに固溶して融点を低下させるため上記関係式を満足することが好ましい。関係式を満たさない場合は、ろう付熱処理時の溶融ろうによる侵食を受けやすくなったり、フィン材自身が溶融するなどの不具合が生じる。

【００１８】

Ｚｒ：０．０５～０．２０％、Ｔｉ：０．０１～０．３０％

Ｚｒ、Ｔｉは、ろう付後に微細な金属間化合物として分散し、強度を向上させる。Ｚｒ：０．０５％未満、Ｔｉ：０．０１％未満であると上記効果が小さく、Ｚｒ：０．２０％超、Ｔｉ：０．３０％超であると、鋳造性や圧延性が著しく低下する。

【００１９】

Ｉｎ：０．００１～０．２０％、Ｓｎ：０．０１～０．５０％

Ｉｎ、Ｓｎは、非接合部材よりも電位を卑にし、犠牲陽極材として作用する。Ｉｎ：０．００１％未満、Ｓｎ：０．０１％未満であると上記効果が小さく、Ｉｎ：０．２０％超、Ｓｎ：０．５０％超であると自己腐食速度が著しく大きくなる。また、圧延性が低下する。

【００２０】

鋳造時の冷却速度：１５～１０００℃／Ｓ

鋳造時の冷却速度を、１５～１０００℃／Ｓとすると、冷却速度が速いため、粗大晶出物の形成を抑制することができ、さらなる圧延性の向上と強度向上ができる。なお、冷却速度を１０００℃／Ｓより速くしても一層の効果が得られないため、冷却速度は１５～１０００℃／Ｓに設定する。

【００２１】

【発明の実施の形態】
本発明のフィン材に用いるアルミニウム合金は、上記組成に従って常法により製造することができる。本発明のフィン材は製造方法が限定されるものではない。上記により得られたフィン材は、通常はコルゲート加工を施してフィンとする。上記フィンは、チューブ間に設置するなどして組付けられ、ろう付処理が行われ熱交換器が得られる。
【００２２】
【実施例】
表１に示す組成のアルミニウム合金を鋳造時の冷却速度を変えて鋳造し、熱間圧延およびまたは冷間圧延、中間焼鈍、冷間圧延を施すことにより、０．０６ｍｍの板厚の圧延材を作製した。
【００２３】
ろう付後の引張強さ
ろう付後のフィン材の強度の評価として、フィン材単体を高純度窒素ガス雰囲気中でろう付相当熱処理（６００～６１０℃×５分、冷却速度１００℃／分）を施し引張試験を行い、引張強さを測定した。ＡＡ３００３合金を用いて作製された従来のフィン材の引張強さが１１０ＭＰａであることから、引張強さが１４５ＭＰａ以上あったものを十分に強度があると判定した。
【００２４】
圧延性
フィン材の圧延性は、圧延後のサイドクラックの合計長さを圧延後の材料の長さで除した値、により評価した。板厚２ｍｍまで圧延後、端面を同一条件に切削し、２００ｍｍ長さ×１００ｍｍ幅のサンプルを得た。その後、５６０℃で６０ｓの中間焼鈍を行った（いずれの材料も完全に軟化させるための条件とした）。その後、０．１ｍｍまで冷間圧延を施し、圧延性を評価した。なお、０．５ｍｍ未満のサイドクラックは実質上問題とならないと判断し、０．５ｍｍ以上のサイドクラックを対象とした。０．１５以下であれば十分な圧延性であると判断した。
【００２５】
耐ろう侵食性
ろう付熱処理時のろうによる侵食やフィン材自身の溶融によりフィン材の座屈などについて評価するため、ろう付熱処理相当１０℃／ｍｉｎの速度で昇温した際のフィン材溶融開始温度について調査した。ろう付熱処理温度が６００℃程度で実施されていることからフィン材溶融開始温度が６１０℃以上であるものを耐ろう侵食性が十分であると判断した。
【００２６】
各評価の結果を表１に示すが、本発明材は、いずれも優れた強度、圧延性を示した。
【００２７】
【表１】

	合金組成(重量%)									Mn/(Si+Fe)	Mn−(Si+Ni)	鋳造冷却速度(℃/s)	ろう付後引張強さ(MPa)	圧延性	フィン溶融開始温度(℃)
	Si	Fe	Mn	Zn	Ni	Zr	Ti	In	Sn						
実施例1	1.0	0.2	2.4	1.5	−	−	−	−	−	2.00	−	200	160	0.07	623
実施例2	1.0	0.2	2.4	1.5	0.5	−	−	−	−	2.00	0.9	200	172	0.12	617
実施例3	1.0	0.2	2.4	1.5	−	0.1	0.1	−	−	2.00	−	200	165	0.10	623
実施例4	1.0	0.2	2.4	1.5	−	−	−	0.05	0.1	2.00	−	200	160	0.11	622
実施例5	1.0	0.2	2.4	1.5	0.5	0.1	0.1	−	−	2.00	0.9	200	176	0.12	616
実施例6	1.0	0.2	2.4	1.5	0.5	−	−	0.05	0.1	2.00	0.9	200	172	0.11	615
実施例7	1.0	0.2	2.4	1.5	−	0.1	0.1	0.05	0.1	2.00	−	200	165	0.09	623
実施例8	1.0	0.2	2.4	1.5	0.5	0.1	0.1	0.05	0.1	2.00	0.9	200	177	0.10	616
実施例9	1.0	0.2	2.4	1.5	0.5	−	−	−	−	2.00	0.9	10	155	0.14	616
実施例10	1.0	0.05	2.4	1.5	−	−	−	−	−	2.29	−	200	165	0.12	616
比較例1	1.5	0.3	2.4	1.5	1.0	−	−	−	−	1.33	−0.1	200	140	0.18	595
比較例2	1.0	0.2	1.5	1.5	0.5	−	−	−	−	1.25	0.9	200	158	0.16	617
比較例3	1.0	0.8	2.4	1.5	−	−	−	−	−	1.33	−	200	145	0.19	620

【0028】

【発明の効果】

以上説明したように、本発明の圧延性に優れた自動車熱交換器用高強度アルミニウム合金フィン材及びその製造方法によれば、優れた強度、圧延性を有するフィン材が得られる。